

REMARKS

Claims 1, 4, 7 through 9, 11, 14, 15 and new Claim 16 are pending.

Claims 1, 14 and 15 have been amended to reflect advantageous embodiments in which the cellulose ethers are selected from methylhydroxyethylcellulose, methylhydroxypropylcellulose or ethylhydroxyethylcellulose. Support for this amendment can be found in the Application-as-filed.

Claims 14 and 15 have been amended to emphasize advantageous inventive cellulose ethers consisting of cellulose ether and chemical compounds containing at least one aldehyde group and at least one acid group. Support for this amendment can be found in the Application-as-filed.

Claim 16 has been added to complete the record for examination and highlight particularly advantageous embodiments of the invention.

Claim 16 reflects advantageous embodiments in which the chemical compound having at least one acid group and at least one aldehyde group is glyoxylic acid. Support for this amendment can be found in the Application-as-filed.

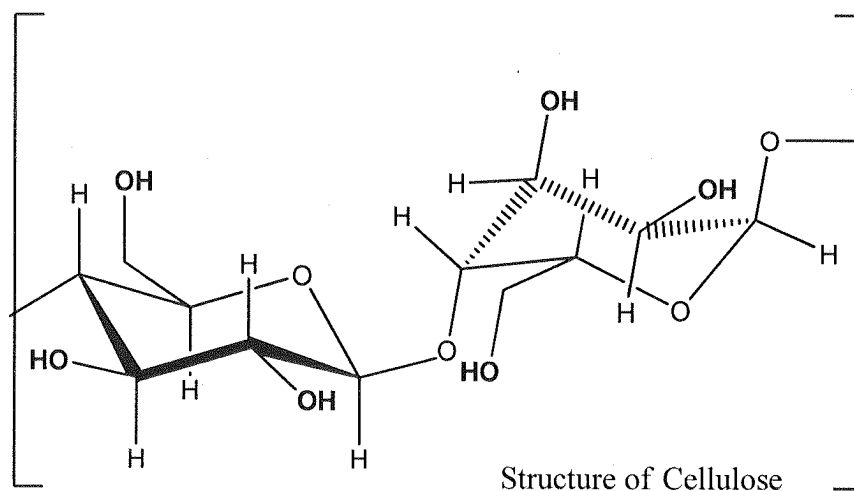
Reexamination and reconsideration of this application, withdrawal of all rejections, and formal notification of the allowability of the pending claims are earnestly solicited in light of the remarks which follow.

The Claimed Invention is Patentable in Light of the Art of Record

Claims 1, 4, 6 through 9, 11, 12, 14 and 15 stand rejected over United States Patent No. 3,072,635 to Menkart et al in light of newly cited United States Patent No. 2,879,268 to Jullander and United States Patent No. 4,366,070 to Block..

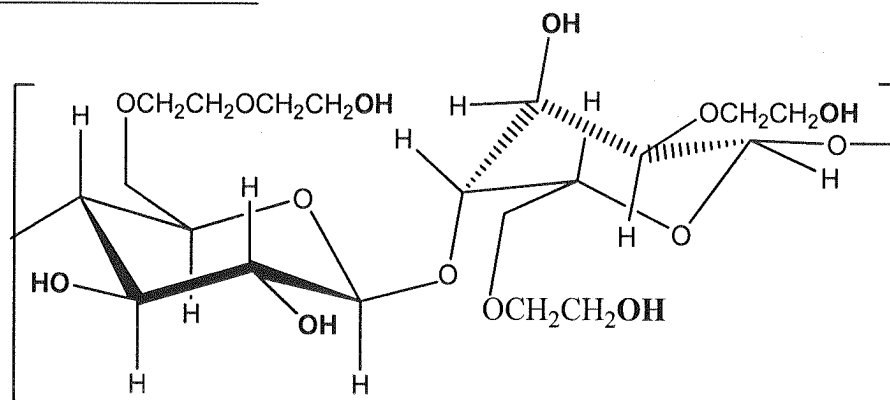
It may be useful to briefly consider the invention before addressing the merits of the rejection.

A wide variety of celluloses are known. Cellulose is formed from anhydroglucose units, each of which contains three hydroxyl groups providing bonding sites for the cellulose molecule. The structure of cellulose is provided below (with functional hydroxy groups in bold):



Cellulose may be further reacted to produce a wide variety of products, as is well known in the art. Cellulose may be reacted with alkyl oxides or the like to produce a variety of cellulose ethers, for example. Cellulose ethers are known as viscosity builders and the like for a wide variety of applications. Several types of cellulose ethers are available, including alkyl cellulose, hydroxyalkyl cellulose and alkyl hydroxyalkyl cellulose.

An idealized chemical structure for hydroxyethyl cellulose, an exemplary hydroxyalkyl cellulose, is provided below (with functional hydroxy groups in bold):

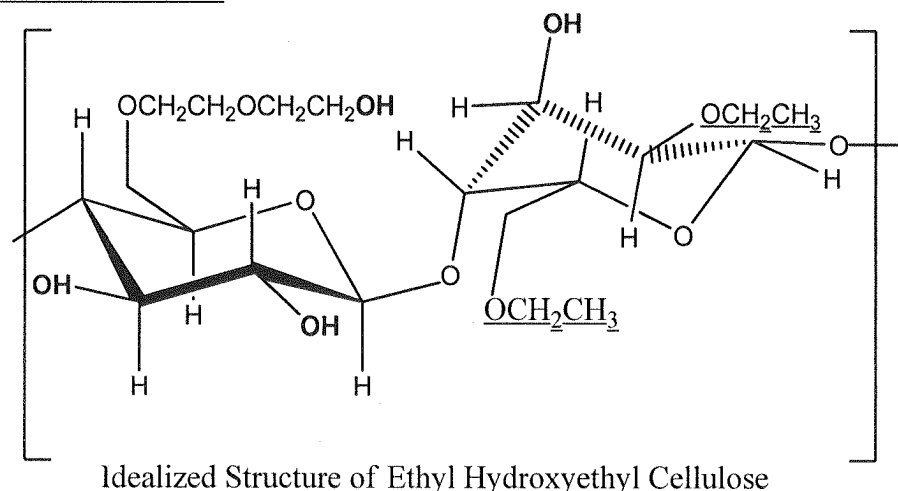


Idealized Structure of Hydroxyethyl Cellulose

As indicated in the structure above, in hydroxyalkyl cellulose, one more of the hydroxyl groups on the cellulose molecule have been replaced by a hydroxyalkyl group. The Examiner will kindly note, however, that 3 hydroxyl moieties remain on each anhydroglucose units, although one or more of such groups is present as a hydroxyalkyl group.

As noted above, alkyl hydroxyalkyl celluloses are also known in the art. In contrast to hydroxyalkyl cellulose, alkyl hydroxyalkyl celluloses have replaced at least one hydroxyl group on at least one of its anhydroglucose units with an alkyl group. Consequently, Applicants respectfully submit that alkyl hydroxyalkyl ether celluloses are far less reactive than hydroxyl alkyl ether celluloses, because they contain at least one fewer hydroxy moiety on the cellulose molecule, as is well known in the cellulosic art.

An idealized chemical structure for ethyl hydroxyethyl cellulose, an exemplary alkyl hydroxyalkyl cellulose, is provided below (with functional hydroxy groups in bold and inert alkyl ether groups in underline):



Applicants respectfully reiterate that the production of aqueous solutions containing cellulose ethers can be problematic. If such a cellulose ether powder comes into contact with water, the individual granules swell and clump together to form relatively large agglomerates.

Cellulose ethers crosslinked with glyoxal are known to have reduced swelling, as clearly evidenced by both Menkart and newly cited Jullander. Carbaldehyde groups on the glyoxal readily react with the cellulose ether to form hemiacetal bonds. Hemiacetal bonds are pH sensitive, and cleave when the cross-linked cellulose ether is stirred into neutral or weakly acidic water, as discussed in the Application-as-filed on Page 2, lines 26 through 30. Considered differently, the glyoxal cross-link is broken by the water, releasing the glyoxal back into solution and restoring the hydroxyl group on the cellulose ether. The reintroduction of the glyoxal back into solution is highly problematic, particularly from a health and safety standpoint.

Alternative crosslinkers to glyoxal are generally known for various resins. Unfortunately, Applicants have determined that cellulose ethers formed using alternative crosslinkers form lumps upon introduction into an aqueous solution, as indicated in Comparative Example 2 within Dr. Schultz's declaration submitted with Applicants Amendment of October 30, 2009. Altogether unexpectedly, Applicants have found particular crosslinkers and processes by which specific crosslinked cellulose ethers can be formed that eliminate the heretofore known lump

formation which occurs upon introducing the crosslinked cellulose ether into an aqueous solution.

Applicants have particularly found that methods of forming crosslinked cellulose ether that initially merely moisten but do not dissolve the cellulose ether as it is combined with a chemical compound containing at least one aldehyde group and at least one acid group, especially in an amount ranging from 0.01 to 0.1 mol per mole of cellulose ether, exhibit lump-free stirrability upon subsequent introduction of the crosslinked cellulose ether into aqueous solutions. In addition, the inventive reversibly crosslinked ethers do not release low molecular weight compounds upon dissolution in aqueous solutions, i.e. the acid moiety remains attached to the cellulose ether as it is dissolved.

In particularly expedient embodiments, the cellulose ethers are selected from methyl hydroxyethyl cellulose, methyl hydroxypropyl cellulose or ethyl hydroxyethyl cellulose, as reflected in the claims as-amended. Applicants respectfully submit that the efficacy of the recited compound containing at least one aldehyde group and at least one acid group in crosslinking the recited alkyl hydroxyalkyl celluloses is altogether unexpected. Applicants more specifically respectfully submit that the advantageous efficacy of a less reactive crosslinker, i.e. the recited compound containing at least one acid group versus conventional aldehyde or dialdehydes, in combination with a less reactive cellulose ether, i.e. the recited alkyl cellulose ether versus hydroxyalkyl cellulose, was quite surprising.

The beneficial combination of the recited less effective reactants in a process that initially merely moistens but does not dissolve the cellulose ether was similarly altogether unexpected. That such a combination would result in crosslinked cellulose ethers having lump-free stirrability on stirring into aqueous solutions was completely unforeseen.

In advantageous embodiments, the alkyl hydroxyalkyl cellulose is pre-moistened with either 40 to 80 % water or 30 to 60% organic suspension medium, as recited in Claim 11.

In especially beneficial inventive embodiments, the chemical compound having at least one acid group and at least one aldehyde group is glyoxylic acid, as recited in newly added Claim 16.

Applicants respectfully reiterate that the cited references do not teach or suggest the claimed invention, considered either alone or in combination.

Applicants specifically respectfully submit that the only reference disclosing an acid group reaction with cellulose is Block, but Block requires hydroxyalkyl cellulose, a far more reactive cellulose than the alkyl hydroxyalkyl celluloses recited within the claims as-amended. And there would have been absolutely no motivation to have substituted the recited alkyl hydroxyalkyl cellulose for the hydroxyalkyl cellulose of Block, as there would have been no expectation of success. Specifically, there would have been no expectation of success in combining a less reactive cellulose ether, i.e. the recited alkyl hydroxyalkyl celluloses, with a less reactive crosslinker, i.e. the recited compound containing at least one acid group. One skilled in the art would instead have combined such less reactive cellulose ether, i.e. the recited alkyl hydroxyalkyl celluloses, with a more reactive crosslinker, such as the aldehydes and dialdehydes of Menkart and Jullander.

And one skilled in the art most certainly would not have been motivated to have combined a less reactive crosslinker with a less reactive cellulose ether that is not dissolved, as further recited in the claimed invention. Applicants respectfully submit that conventional wisdom instead suggests that whatever hydroxyl functionality remains on the recited alkyl hydroxyalkyl cellulose ethers would have more easily accessed by crosslinker within a dilute solution due, inter alia, to the greater molecular mobility provided by such dilute solutions. Applicants found, however, that the use of such dilute solutions gave rise to lump formation. Applicants further determined, altogether unexpectedly, that such dilute solutions were not necessary.

Accordingly, Applicants respectfully submit that the claimed invention is patentable in light of the cited references, considered either alone or in combination.

Specifically, newly cited Jullander does not cure the earlier noted deficiencies within Menkart and Block.

Jullander is generally directed to cellulose ethers having less of a tendency to form agglomerates when wetted by water of aqueous alkali. (Col. 1, lines 12 – 23). Jullander notes that, during aqueous dissolution, cellulose ethers particles can either become encapsulated within a “gelatinous film” formed on the particle surface or form agglomerates, either of which ultimately results in lump formation during dissolution. (Col. 1, lines 24 – 60). Evidencing conventional wisdom, Jullander teaches the reaction of “substances containing hydroxyl groups” with “small amounts” of “formaldehyde or a dialdehyde” to address such lump formation. (Col. 2, lines 53 – 62). Jullander notes that his invention is especially directed to cellulose ethers, but could be applicable to “other high-molecular hydroxyl-bearing water-soluble substances.” (Col. 4, lines 11 – 17). Jullander teaches reacting the cellulose ether “in solid form,” which he goes on to define as “fibres, granules or powder.” (Col. 4, lines 46 – 50). Jullander provides a laundry list of aldehydes, including an number of lower aliphatic dialdehydes. (Col. 4, lines 31 – 45). Jullander is altogether silent as to crosslinkers containing an acid group, however.

Although noting reaction in a “solid form,” Jullander’s working Example 1 is curiously based on a 2 % cellulose solution. (Col. 4, lines 54 – 60). Jullander’s working Examples 14 and 15 initially form dilute cellulose solutions that are either filtered (Ex 14) or centrifuged (Ex 15) to 50 % solids onto which glyoxal is either poured (Ex 14) or combined in an extrusion press (Ex 15). (Col. 7, line 56 – Col. 8, line 11). In contrast to the inventive comminution step as recited in Claims 14 and 15, Jullander expressly teaches that the glyoxal concentration or increased shear provides uniform distribution of the glyoxal throughout the cellulose cake. (Col. 7, lines 66 – 69 and Col. 8, lines 12 - 14).

Applicants respectfully reiterate that, similar to Menkart, Jullander does not teach or suggest the inventive methods for producing reversibly-crosslinked cellulose ethers in which cellulose ethers having free OH groups are admixed with chemical compounds containing at least one acid group. Although providing a laundry list of aldehyde crosslinkers, Jullander is altogether silent as to any further alternative crosslinkers.

Applicants further respectfully submit that there would have been no motivation for Jullander to have combined the recited chemical compounds containing at least one acid group with the alkyl cellulose ethers of the claims-as-amended, as there would have been no expectation of success, based upon the lower reactivity of the recited acid groups in comparison to the aldehydes and dialdehydes of Jullander, and further in light of the likewise lower reactivity of the alkyl cellulose ethers recited in Claim 1 as-amended.

Jullander further does not teach or suggest that methods for producing reversibly crosslinked cellulose ethers comprising first admixing, but not dissolving, cellulose ethers in water or an organic suspension medium along with chemical compounds containing at least one aldehyde group and at least one acid group, much less that such mixing would result in reversibly crosslinked cellulose ethers providing lump-free stirrability, as recited in the claimed invention. Jullander simply does not recognize initial cellulose ether concentration as a result effective variable in imparting lump-free stirrability.

Nor does Jullander teach or suggest that chemical compounds containing at least one aldehyde group and at least one acid group are not released upon dissolving said reversibly crosslinked cellulose ether in a neutral or weakly acidic aqueous solution, as further recited in Claim 1. As noted above, Jullander is instead altogether silent as to crosslinkers other than aldehyde or dialdehyde, which are well known to release upon dissolution.

Jullander likewise fails to teach or suggest that processes in which cellulose ether is pre-moistened with either 40 to 80 % water or 30 to 60% organic suspension medium would result in lump-free stirrability, as recited in Claim 11. In contrast to the urgings in the Office Action on Page 5, second full paragraph, Jullander clearly teaches away from such advantageous embodiments by expressly teaching the initial formation of an 8 % cellulose solution which is subsequently filtered or centrifuged to form a more concentrated “mass cake.”

Nor does Jullander teach or suggest particularly beneficial embodiments in which the cellulose ether is pre-moistened with 40 to 80% water, the pre-moistened cellulose is admixed with water and chemical compounds containing at least one aldehyde group and at least one acid group, the admixed cellulose ether composition is comminuted; the comminuted cellulose ether composition is milled and the milled cellulose ether composition is then crosslinked to form an ester or hemiacetal bond, as recited in Claim 14. Applicants respectfully reiterate that the recited comminuting and milling provide significant and altogether unexpected benefits over mere filtration or shear mixing, as provided in Jullander’s filtration or extrusion.

Jullander thus likewise fails to teach or suggest expedient embodiments that include (i) pre-suspending cellulose ether having free OH groups in 30 to 60% organic suspension medium; (ii) admixing the pre-suspended cellulose ether with an organic suspension medium and chemical compounds containing at least one aldehyde group and at least one acid group; (iii) filtering the admixed cellulose ether composition; (iv) drying the filtered cellulose ether composition; (v) comminuting the filtered cellulose ether composition; and (vi) heating the comminuted cellulose ether composition to react the acid groups and aldehyde groups of the chemical compounds with the OH groups of the cellulose ethers to form an ester bond or hemiacetal bond at a temperature ranging from 50 to 105 °C, as recited in Claim 15.

Accordingly, Applicants respectfully submit that the presently claimed method is likewise patentable in light of Jullander, considered either alone or in combination with the remaining art of record.

As noted above, Menkart and Block simply do not cure the deficiencies in Jullander.

As with Jullander, Menkart is merely directed to the conventional use of aldehyde treating agents with cellulose ether, particularly sodium carboxymethyl cellulose. (Col. 1, lines 45 – 58; Col. 4, lines 1 – 5; Col. 4, line 24; Col. 4, line 44; Col. 4, line 59 and Col. 5, lines 55 - 60). Menkart generally indicates that any of glyoxal, formaldehyde or succinaldehyde may be reacted with cellulose ethers, with glyoxal being preferred. (Col. 1, lines 48 – 50).

Menkart generically teaches that moisture is important for “good contact” with the treating agent. (Col. 3, lines 4 – 6). In contrast to the inventive methods, Menkart teaches that processes forming either dilute solutions or those merely dampening the cellulose ether are equivalent to form crosslinked cellulose ethers. Menkart particularly expressly teaches the use of dilute cellulose ether solutions, such as a 10 % cellulose ether solution in alcohol. (Col. 5, lines 55 – Col. 6, line 4). Menkart alternatively teaches the spraying of glyoxal onto “moist” cellulose particles containing up to 90 % cellulose ether (i.e. as little as 10% moisture). (Col. 3, lines 8 – 11 and lines 50 – 55) Menkart’s working example directed to spray application incorporates cellulose ether containing about 80 % cellulose ether (i.e. about 20% moisture). (Col. 6, line 70 – Col. 7, line 3). In fact, Menkart even discloses the treatment of presumably dry cellulose ether on a wire screen with glyoxal vapor. (Col. 3, lines 67 – 70). Menkart expressly teaches that “when employing a solvent for the aldehyde treating agent,” the cellulose ether can first be “suspended in” the solvent containing the aldehyde treating agent for up to 30 minutes after which the liquid is separated off and the cellulose ether containing the absorbed aldehyde solution is dried. (Col. 3, lines 34 – 40). Applicants respectfully reiterate that Menkart is altogether silent as to any definition for “suspended in.”

Applicants respectfully reiterate that the presently claimed method is patentable in light of Menkart, considered either alone or in combination with the remaining art of record, based upon the reasoning provided in Applicant’s Amendment of October 30, 2010.

Applicants respectfully submit that the claimed invention is likewise patentable in light of Block.

Applicants respectfully reiterate that Block is generally directed to improved well drilling fluids. (Col. 1, lines 17 – 20). In contrast to the urgings in the outstanding Office Action on Page 5, first full paragraph and Page 9, first full sentence, Block is solely directed to a cross-linked hydroxyalkyl cellulose, not a cross-linked alkyl hydroxyalkyl cellulose. In fact, Block provides a laundry list of suitable hydroxyalkyl celluloses, including hydroxymethyl cellulose and hydroxyethyl cellulose. (Col. 5, lines 6 – 12).

In addition to its cross-linked hydroxyalkyl cellulose, the drilling fluids of Block further include an aluminum compound to impart the desired rheology. (Col. 3, line 42 – 56 and Col. 6, lines 10 – 16). Block expressly cautions that crosslinked cellulose alone does not impart adequate rheological properties, and thus must be used in combination with an aluminum agent. (Col. 6, lines 31 – 35 and Col. 10, lines 18 - 20).

Block indicates that any of a generic laundry list of cellulosic crosslinking agents is suitable for its cellulose. (Col. 5, lines 24 – 55). Block's working examples incorporate glyoxal, paraformaldehyde or epichlorohydrin along with the cellulose. (Col. 9, lines 14 – 39). Block merely generically notes that the crosslinked hydroxyalkyl cellulose may be formed by reacting the cellulose ether in an aqueous medium, followed by "conventional" recovery techniques associated with the recovery of dissolved components from solutions, such as precipitation, filtration and drying. (Col. 5, line 63 – Col. 6, line 2). The working examples indicate that the "aqueous medium" is a 5 % solution of HEC. (Col. 5, lines 63 – 65 and Col. 9, lines 14 – 35).

Accordingly, Applicants respectfully reiterate that the presently claimed method is patentable in light of Block, considered either alone or in combination with the remaining art of record, based upon the reasoning provided in Applicant's Amendment of October 30, 2010.

Applicants respectfully submit that there would have been no motivation to have combined Menkart, Jullander and Block. Menkart and Jullander are both solely directed to aldehyde treating agents. Block is directed to drilling fluid compositions that include hydroxyalkyl cellulose, an aluminum agent and any of a number of crosslinking agents. Applicants respectfully reiterate that these are extraordinarily different fields of endeavor.

However, even if Applicants had combined Menkart, Jullander and Block (which they did not), the claimed invention would not result.

The combination simply does not teach or suggest that methods for producing reversibly crosslinked cellulose ethers comprising first admixing, but not dissolving, alkyl cellulose ethers in water or an organic suspension medium along with chemical compounds containing at least one acid group would result in reversibly crosslinked alkyl cellulose ethers providing lump-free stirrability, as recited in the claimed invention. Menkart and Jullander both teach that dilute solutions and incredibly concentrated solutions are equivalent for forming their aldehyde-crosslinked celluloses. Block merely teaches the crosslinking of hydroxyalkyl cellulose in dilute solutions.

As evidenced in the Declaration by Dr. Schultz submitted with Applicant's Amendment of October 30, 2009, the use of compositions in which the cellulose ether is first admixed but not dissolved with an agent containing both an aldehyde group and an acid group unexpectedly resulted in reversibly crosslinked cellulose ethers providing lump-free stirrability, in comparison to the lumps formed in dilute solutions. In contrast to the urgings of the outstanding Office Action on Page 7, the testing performed by Dr. Schultz clearly evidences the benefits of the inventive methods in comparison to dilute reaction methods, regardless of whether Block is considered the closest art.

Nor does the combination teach or suggest that chemical compounds containing at least one aldehyde group and at least one acid group are not released upon dissolving the reversibly crosslinked cellulose ether in a neutral or weakly acidic aqueous solution, as further recited in Claim 1.

And the combination most certainly does not teach or suggest the inventive methods for producing lump-free reversibly-crosslinked cellulose ethers by admixing cellulose ethers selected from methyl hydroxyethyl cellulose, methyl hydroxypropyl cellulose or ethyl hydroxyethyl cellulose with chemical compounds containing at least one acid group, as recited in Claim 1 as-amended. As noted above, it was altogether unexpected that the recited less reactive cellulose ethers would react with the recited chemical compounds containing at least one acid group, which are likewise less reactive than other known crosslinkers. Applicants further respectfully submit that the urgings within the outstanding Office Action on Page 5, first full paragraph that the glyoxylic acid of Block is equivalent to the glyoxal of Jullander and Menkart are pure conjecture. Applicants respectfully submit that “the skilled artisan” would instead have no expectation of success in combining the far less reactive glyoxylic acid with the more inert alkyl cellulose ethers recited within Claim 1 as-amended.

And the combination likewise does not teach or suggest that processes in which cellulose ether is pre-moistened with either 40 to 80 % water or 30 to 60% organic suspension medium would result in lump-free stirrability, as recited in Claim 11. Applicants respectfully submit that none of the references indicate cellulose concentration as a result effective variable in lump formation. Jullander and Menkart instead teach that a wide range of cellulose solution concentrations provide equivalent efficacies.

The combination similarly fails to teach or suggest the particularly beneficial methods of forming cellulose ethers in which the cellulose ether is pre-moistened with 40 to 80% water, the pre-moistened cellulose is admixed with water and chemical compounds containing at least one aldehyde group and at least one acid group, the admixed cellulose ether composition is comminuted; the comminuted cellulose ether composition is milled and the milled cellulose ether

composition is then crosslinked to form an ester or hemiacetal bond, as recited in Claim 14. Menkart merely teaches mixing or tumbling. Jullander teaches filtration or extrusion. Block teaches “contacting” or “reacting.”

And the combination most certainly does not teach or suggest such beneficial cellulose ethers consisting of cellulose ether and chemical compounds containing at least one aldehyde group and at least one acid group, as further recited in Claim 14 as-amended. Applicants respectfully submit that Block expressly requires a hydroxyl-containing aluminum agent. Applicants respectfully submit that to modify Block so as to avoid its required aluminum agent would render it unfit for its intended purpose as a well drilling fluid, as admitted by Block.

The combination thus also fails to teach or suggest expedient methods of forming cellulose ethers consisting of cellulose ether and chemical compounds containing at least one aldehyde group and at least one acid group that include (i) pre-suspending cellulose ether having free OH groups in 30 to 60% organic suspension medium; (ii) admixing the pre-suspended cellulose ether with an organic suspension medium and chemical compounds containing at least one aldehyde group and at least one acid group; (iii) filtering the admixed cellulose ether composition; (iv) drying the filtered cellulose ether composition; (v) comminuting the filtered cellulose ether composition; and (vi) heating the comminuted cellulose ether composition to react the acid groups and aldehyde groups of the chemical compounds with the OH groups of the cellulose ethers to form an ester bond or hemiacetal bond at a temperature ranging from 50 to 105 °C, as recited in Claim 15 as-amended.

Accordingly, Applicants respectfully submit that the claimed invention is patentable in light Menkart, Jullander and Block, considered either alone or in combination.

CONCLUSION

It is respectfully submitted that Applicants have made a significant and important contribution to the art, which is neither disclosed nor suggested in the art. It is believed that all

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of pending Claims 1, 4, 7 through 9, 11, and 14 through 16 are now in condition for immediate allowance. It is requested that the Examiner telephone the undersigned if any questions remain to expedite examination of this application.

It is not believed that extensions of time or fees are required, beyond those which may otherwise be provided for in documents accompanying this paper. However, in the event that additional extensions of time and/or fees are necessary to allow consideration of this paper, such extensions are hereby petitioned under 37 CFR § 1.136(a), and any fee required is hereby authorized to be charged to Deposit Account No. 50-2193.

Respectfully submitted,

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I hereby certify that this correspondence is being electronically transmitted to the United States Patent and Trademark Office PAIR electronic filing system in accordance with § 1.6(a)(4) on March 11, 2010. *Claire Wygand* Claire Wygand